CHEMISTRY AND MINERALOGY OF FERROMANGANESE DEPOSITS FROM THE EQUATORIAL PACIFIC OCEAN

Eric H. De Carlo and Charles M. Fraley
Hawaii Institute of Geophysics, Honolulu, Hawaii 96822 U.S.A.

ABSTRACT

Ferromanganese nodules, crusts, and phosphatic substrates were recovered during two cruises of the R/V Moana Wave to the Cook Islands, Kiribati, and Tuvalu. We report the geochemistry and mineralogy of ferromanganese crusts and seamount nodules only. Samples were collected from flanks, gentle slopes, and nearly flat summits; nodules were absent from the steeper slopes. Cobalt, the metal of highest commercial interest, ranges between 0.19% and 1.90% by weight in deposits consisting of stains of less than one millimeter to a maximum of 12 cm thick. The highest Co dredge averages of 1.72% and 1.30% were found in crusts recovered near Vaitupu and Enderbury islands respectively. Most crusts from the Manihiki Plateau were less than one centimeter thick and exhibited low metal values in contrast to those from a region of mud volcanoes on the plateau in which Co concentrations averaged 1.0%. Copper and Ni dredge averages ranged from 0.05% to 0.14% and from 0.19% to 0.89% respectively.

The results of this study are generally in agreement with observations in other areas of the Pacific, and confirm the following criteria for seeking high metal grades in vernadite-rich ferromanganese deposits: 1) water depth of 1000-2000 m, 2) latitude 2-7°S, and 3) low sedimentation rates. Crusts of potential commercial interest occur primarily in the vicinity of Vaitupu and Enderbury Islands, but other gently sloped ridges and seamount summits in the Line Islands (near 1°S, 156°W) have abundant nodules or encrusted cobbles averaging 0.78% Co and 0.63% Ni.

The mineralogy of crusts is dominated by vernadite with few samples enriched in todorokite. Seamount nodules are chemically and mineralogically distinct from their abyssal counterparts; like crusts they are primarily composed of vernadite. No crystalline iron phases were identified within Fe-Mn deposits. Phosphate bands are generally absent within crusts but commonly occur in substrates of samples collected above 2500 m. The phosphorite material in crusts and substrates is primarily carbonate fluorapatite replacing calcium carbonate.

INTRODUCTION

In early 1986 and 1987 the R/V Moana Wave carried out two one-month mineral assessment cruises within territorial waters of the Cook Islands, Kiribati, Tuvalu and Western Samoa, in the south equatorial Pacific. This paper summarizes results of chemical and mineralogical studies on ferromanganese crusts and seamount nodules; deep-sea nodules and phosphorites from the region are discussed elsewhere in this volume (Bolton et al., 1990; Rao and Burnett, 1990; Usui and Moritani, 1990). Studies of deep-sea nodules in the past two decades have led to numerous papers on their distribution, abundance, geochemistry and mineralogy (Glasby, 1977; Meylan et al., 1981; and references therein). Although the existence of deep-sea nodules and of Fe-Mn crusts, recently termed Co-rich crusts, has been known since the HMS Challenger expedition of the 1870's (Glasby, 1977), crusts have not until recently received the attention given to nodules. The shift in interest has been attributed to the high content of the strategic metal Co in crusts (three to five times that of abyssal nodules), their potential as a source of